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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: HIROSHI MORITA ET AL

Serial No.: TO BE ASSIGNED

Filed: February 27, 2002

Title: SUPERCONDUCTOR CONNECTION STRUCTURE

PRELIMINARY AMENDMENT

Box Non-Fee Amendment
Commissioner for Patents
Washington, D.C. 20231

Sir:

Please enter the following amendments to the specification and claims prior to the examination of the application.

IN THE SPECIFICATION:

Please amend the specification as follows **(a marked-up version of the specification as amended is attached hereto)**:

Please replace the paragraph bridging pages 1 and 2 with the following paragraph:

A superconducting magnet apparatus, superconducting power cable or the like may require electrical connection of two or more superconducting lines. For example, electric resistance at a connection point must be minimized in the permanent current operated superconducting magnet apparatus, thereby reducing the damping factor of magnetic field produced by a magnet. Further,

refrigerant consumption is increased by heat generated at the connection point in a superconducting power cable carrying a large current. This requires electric resistance to be reduced at the connection. A method for electrical connection of two or more superconducting lines is found in Japanese Application Patent Laid-Open Publication No. 2001-102105 which discloses a method for solidifying the superconducting line subsequent to soaking it in the melt of metal or alloy.

On Page 2, please replace the paragraph between lines 13 and 24 with the following paragraph:

As shown in the description of the prior art, a superconducting line can be electrically connected by a method for solidifying the superconducting line subsequent to soaking it in the melt of metal or alloy. This method, however, involves complicated steps and a complex structure. Further, critical magnetic field of the metal or alloy is 1T or less, and the connection point cannot be laid out in high magnetic field. Moreover, there remains a problem of the superconducting line being denatured due to metal melt at about 500 degrees Celsius, resulting in deteriorated superconducting characteristics.

Please replace the paragraph bridging Pages 3 and 4 with the following paragraph:

The critical magnetic field at 0T is about 18T. It does not exceed 10T when liquid helium is at 4.2K. According to the prior art connection technique in the superconducting magnet, the critical magnetic field of the connection point may be reduced, and this was accompanied by the following restrictions: A connection point had to be installed at a small space away from the superconducting magnet

or a magnetic shield had to be provided outside the connection point. However, when the connection point of a superconducting line is configured through the use of the material according to the present invention, the aforementioned restrictions are removed, with the result that a higher degree of freedom is assigned to the configuration of a connection point.

IN THE CLAIMS:

Please amend claims 1-11, 13 and 15 as follows **(a marked-up version of the amended claims is attached hereto)**:

1. (Amended) A superconducting line connection structure for connecting two or more superconducting lines, wherein the superconducting line connection structure comprises superconductor powder comprising magnesium diboride present between said superconducting lines.

2. (Amended) A superconducting line connection structure according to Claim 1, further comprising a metal powder or an alloy powder in a mixture with the superconducting powder between said superconducting lines.

3. (Amended) A superconducting line connection structure according to Claim 1, wherein the average particle size of said superconducting powder is 20 microns or less.

4. (Amended) A superconducting line connection structure according to Claim 1, wherein said superconducting lines and said superconducting powder are enclosed in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum, niobium, lead, tin, magnesium, indium,

tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals.

5. (Amended) A superconducting line connection structure according to Claim 1, wherein a superconducting filament enclosed in said superconducting line is directly in contact with said superconducting powder at least on some portion of the contact surface between said superconducting line and said superconducting powder.

6. (Amended) A superconducting line connection structure according to Claim 1, wherein the density of said superconducting powder is 50 % or more of theoretical density.

7. (Amended) A method for producing a superconducting line connection structure according to Claim 1, wherein heat treatment of said superconducting line connection structure is not effected.

8. (Amended) A method for producing a superconducting line connection structure according to Claim 1, wherein heating is performed to reach the temperature equal to or higher than the range where a part of (1) said superconducting line, or (2) said superconducting powder melts down.

9. (Amended) A method for producing a superconducting line connection structure according to Claim 4, comprising;

(1) a first step of forming a structure by enclosing said superconducting line and said superconducting powder in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum,

niobium, lead, tin, magnesium, indium, tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals, and

(2) a second step of deforming the portion produced in the first step by applying a pressure of 1 ton/cm^2 or more thereto.

10. (Amended) A superconducting line connection structure according to Claim 1, wherein at least one of said multiple superconducting lines to be connected has a critical temperature equal to or higher than that of magnesium diboride.

11. (Amended) A superconducting line connection structure according to Claim 1, wherein the superconducting line to be connected is a superconducting stranded wire formed by twisting multiple superconducting lines.

13. (Amended) A superconducting magnet apparatus comprising a superconducting line connection structure according to Claim 1.

15. (Amended) A superconducting line comprising a superconducting line connection structure according to Claim 1.

Please add the following new Claims:

16. (New) A superconducting line structure according to Claim 2, wherein the metal powder or alloy powder has a melting point lower than the superconducting powder.

17. (New) A superconducting line connection structure according to Claim 2, wherein said superconducting lines and the mixture of superconducting powder and metal powder or alloy powder are enclosed in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum, niobium, lead, tin, magnesium, indium, tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals.

18. (New) A method for producing a superconducting line connection structure according to Claim 2, wherein heating is performed to reach the temperature equal to or higher than the range where a part of any one of (1) said superconducting line, (2) said superconducting powder and (3) said pure metal powder or said alloy powder melts down.

19. (New) A method for producing a superconducting line connection structure according to Claim 17, comprising;

(1) a first step of forming a structure by enclosing said superconducting line and said mixture in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum, niobium, lead, tin, magnesium, indium, tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals, and

(2) a second step of deforming the portion produced in the first step by applying a pressure of 1 ton/cm^2 or more thereto.

REMARKS

Entry of the amendments to the specification and claims before examination of the application is respectfully requested. These claims have been amended to remove multiple dependencies, and new claims have been added to recite subject matter in removed multiple dependent claims.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

Respectfully submitted,

February 27, 2002

James F. McKeown
Registration No. 25,406
Kening Li, Ph.D.
Registration No. 44,872

CROWELL & MORING, LLP
Intellectual Property Group
P.O. Box 14300
Washington, DC 20044-4300
Telephone No.: (202) 624-2500
Facsimile No.: (202) 628-8844
JFM:KL:tlm
(CAM #: 56207.502)

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph bridging pages 1 and 2 has been amended as follows:

A superconducting magnet apparatus, superconducting power cable or the like may require[s] electrical connection of two or more superconducting lines. For example, electric resistance at a connection point must be minimized in the permanent current operated superconducting magnet apparatus, thereby reducing the damping factor of magnetic field produced by a magnet. Further, refrigerant consumption is increased by heat generated at the connection point in a superconducting power cable carrying a large current. This requires electric resistance to be reduced at the connection. A method for electrical connection of two or more superconducting lines is found in Japanese Application Patent Laid-Open Publication No. 2001-102105 which discloses a method for solidifying the superconducting line subsequent to soaking [of] it in the melt of metal or alloy.

On Page 2, the paragraph between lines 13 and 24 has been amended as follows:

As shown in the description of the prior art, a superconducting line can be electrically connected by a method for solidifying the superconducting line subsequent to soaking [of] it in the melt of metal or alloy. This method, however, involves complicated steps and a complex structure. Further, critical magnetic field of the metal or alloy is 1T or less, and the connection point cannot be laid out in high magnetic field. Moreover, there remains a problem of the

superconducting line being denatured due to metal melt at about 500 degrees Celsius, resulting in deteriorated superconducting characteristics.

The paragraph bridging Pages 3 and 4 has been amended as follows:

The critical magnetic field at 0T is about 18T. It does not exceed 10T when liquid helium is at 4.2K. According to the prior art connection technique in the superconducting magnet, the critical magnetic field of the connection point may be reduced, and this was [accompanies] accompanied by the following restrictions: A connection point had to be installed at a small space away from the superconducting magnet or a magnetic shield had to be provided outside the connection point. However, when the connection point of a superconducting line is configured through the use of the material according to the present invention, the aforementioned restrictions are removed, with the result that a higher degree of freedom is assigned to the configuration of a connection point.

IN THE CLAIMS

Claims 1-11, 13 and 15 have been amended as follows:

1. (Amended) A superconducting line connection structure for connecting [In a structure of electrical connection between] two or more superconducting lines, [a] wherein the superconducting line connection structure [characterized by the presence of] comprises superconductor powder [including] comprising magnesium diboride [provided] present between said superconducting lines.

2. (Amended) A superconducting line connection structure according to Claim 1, [characterized by using] further comprising a metal powder or an alloy powder in a mixture [of] with the superconducting powder [and metal powder] between said superconducting lines [as an alternative to said superconducting powder, wherein metallic powder or alloy powder having a melting point lower than said superconducting powder is added to said mixture of superconducting powder and metal powder].

3. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein the average particle size of said superconducting powder is 20 microns or less.

4. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein said superconducting lines and said [mixture of] superconducting powder [and metal powder] are enclosed in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum, niobium, lead, tin, magnesium, indium, tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals.

5. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein a superconducting filament enclosed in said superconducting line is directly in contact with said superconducting powder at least on some portion of the contact surface between said superconducting line and said superconducting powder.

6. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein the density of said superconducting powder is 50 % or more of theoretical density.

7. (Amended) A method for producing a superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein heat treatment of said superconducting line connection structure is not effected.

8. (Amended) A method for producing a superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein heating is performed to reach the temperature equal to or higher than the range where a part of [any one of] (1) said superconducting line, or (2) said superconducting powder [and (3) said pure metal powder or said alloy powder included in said mixture of superconducting powder and metal powder] melts down.

9. (Amended) A method for producing a superconducting line connection structure according to Claim 4, comprising;

(1) a first step of forming a structure by enclosing said superconducting line and said superconducting powder in a coating material made of a pure metal of gold, silver, copper, platinum, palladium, aluminum, niobium, lead, tin, magnesium, indium, tungsten, cobalt, nickel, iron, tantalum or chromium, or an alloy containing at least one of said metals, and

(2) a second step of deforming the portion produced in the first step by applying a pressure of 1 ton/cm^2 or more thereto.

10. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein at least one of said multiple superconducting lines to be connected [or said multiple superconducting stranded wires] has [the] a critical temperature equal to or higher than that of magnesium diboride.

11. (Amended) A superconducting line connection structure according to Claim 1 [or 2], [characterized in that] wherein the superconducting line to be connected is a superconducting stranded wire formed by twisting multiple superconducting lines.

13. (Amended) A superconducting magnet apparatus [characterized by] comprising a superconducting line connection structure according to Claim 1 [or 2].

15. (Amended) A superconducting line comprising a superconducting line connection structure according to Claim 1 [or 2].